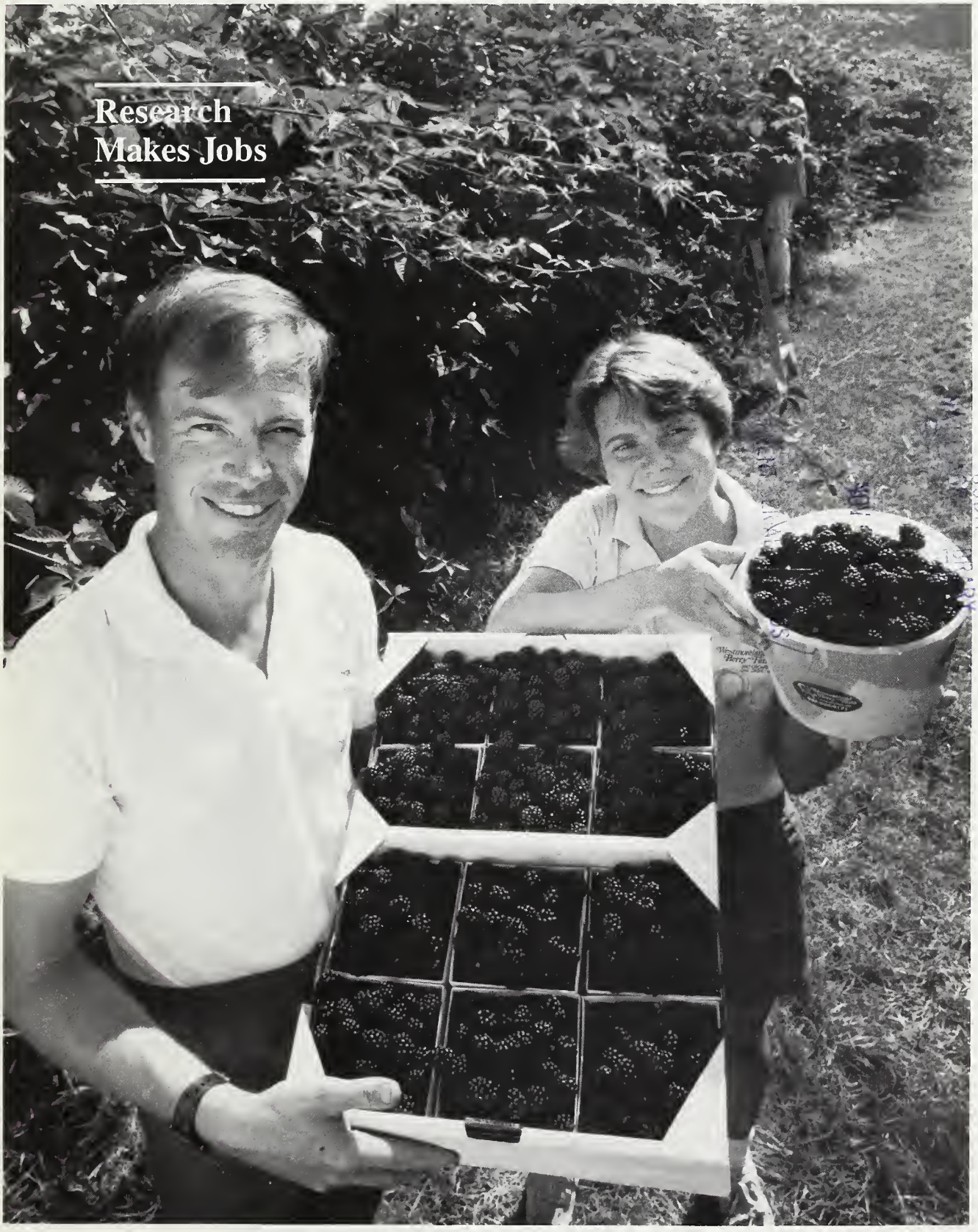
U.S. Department of Agriculture Agricultural Research Service Vol. 35, No. 9, October 1987

Agricultural Research



Research To Help Rural Revitalization

A vein of gold isn't worth a nickel until someone discovers it—and mines it. It's that way with research data, too. The Secretary of Agriculture pointed out this summer that the U.S. Department of Agriculture has an untapped gold mine of practical information that can be put to work by the public in carrying out rural development activities. He has asked USDA agency heads to do all they can to make that information known and available to people who can use it.

In line with Secretary Lyng's request, this issue of *Agricultural Research* focuses on several current research projects in support of rural development. We will publish additional articles on the subject in future issues.

There have been USDA rural development efforts in the past, but none so all-encompassing as that defined by the Secretary.

In the Agricultural Research Service, rural development projects fall into five general categories. We conduct research:

- To help provide new sources of income for rural people, both on and off the farm.
- To develop new products that use farm surpluses and to transfer that technology to industry.
- To enable farmers and ranchers to lower production costs, making their products more competitive in domestic and world markets and increasing their profits.
- To improve the rural environment, making it more attractive to commercial enterprise. (This includes research to safeguard the adequacy, purity, and safety of rural water supplies.)
- To find ways to overcome technical obstacles to agricultural exports, bringing about improvement in our balance of payments and ensuring jobs for more rural Americans.

Research in support of these goals adds up to a significant share of the total scientific effort in ARS, and we work closely with federal and state cooperators to multiply the benefits of our individual efforts. We welcome the opportunity to share some of our findings with our readers.

One article in this issue, for instance, tells of the dramatic changes brought about in rural North and South Carolina by the eradication of the boll weevil. This program, which combines research with a coordinated action program, has increased farm income from cotton in the Carolinas and has brought about substantial new investment in rural business. The success of the program has led to its adoption in other states in the Southeast.

Another article describes how three partners in rural progress—an ARS research lab, a nonprofit marketing corporation, and a group of Oklahoma farmers—are engaged in a planned (and profitable) undertaking to raise alternative crops for pre-arranged markets, including grocery chains and food processors. We hope the Lane, Oklahoma, experience will encourage other rural areas to experiment with similar projects.

Still another article tells how new ARS varieties of thornless blackberries are returning the highest profit of any fruit grown on a thriving pick-your-own farm in Tidewater Virginia.

Other stories deal with new rural industries that manufacture products from surplus commodities such as corn starch using ARS-developed technology.

No area of rural development research is more vital, however, than that to ensure ground water quality. Because an adequate supply of water, free of harmful chemicals and other pollutants, is essential in attracting new industry to any rural community, we are redirecting funds from lower priority research projects to ground water quality research, the number one priority in ARS.

In Georgia, for instance, we have ended work on nutrient management in cropping systems on eroded soils. The funds and personnel have been redirected to determining major pathways by which nitrogen enters the crop root zone and transfers to ground water. The lab has also been assigned the task of developing multiple crop systems to minimize that transfer.

At Urbana, Illinois, research has been halted on synthesis of protein in corn kernels. The funds have been redirected to determining the interactions between soil and pesticides that influence the movement of pesticides to ground water.

Since water is the primary carrier of root zone chemicals to ground water, studies in Washington State to improve irrigation practices have been redirected to developing water and nutrient management practices that will minimize farm chemicals in ground water.

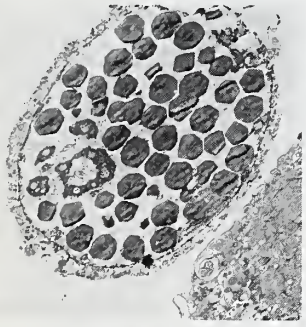
Similar redirection is taking place in Philadelphia and New Orleans. And when our new National Soil Tilth Laboratory is completed in Iowa in 1988, a major goal will be to understand how agricultural production systems affect ground water quality.

These and similar research projects will aid in the revitalization of rural America, a continuing goal of ARS and other USDA agencies.

Terry B. Kinney, Jr.
Administrator

Agricultural Research

Cover: Charles and Anne Geyer display a sample of Agricultural Research Service-developed thornless blackberries grown on a pick-your-own farm they manage in Virginia. See series of stories on Research Makes Jobs beginning on page 6. Photo by Tim McCabe. (0887X805-12)



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Vol. 35, No. 9
October 1987

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Agricultural Research is published 10 times per year by the Agricultural Research Service (ARS), U.S. Department of Agriculture, Washington, DC 20250. The Secretary of Agriculture has determined that the publication of this periodical is necessary in the transaction of the public business required by law of the Department. Send subscription orders to Superintendent of Documents, Government Printing Office, Washington, DC 20402. Information in this magazine is public property and may be reprinted without permission. Prints of photos are available to mass media; please order by month and photo number.

Magazine inquiries should be addressed to: The Editor, Information Staff, Room 318, Bldg. 005, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. Telephone: (301) 344-3280. When writing to request address changes or deletions, please include a recent address label.

Richard E. Lyng, Secretary
U.S. Department of Agriculture

Orville G. Bentley, Assistant Secretary
Science and Education

Terry B. Kinney, Jr., Administrator
Agricultural Research Service

Strides in Spotting Johne's Disease

A new genetic test under development by Agricultural Research Service scientists promises a speedier and more accurate diagnosis of Johne's [YO-NEZ] disease, paratuberculosis, in cattle. Conventional tests currently take 12 to 16 weeks; this highly contagious disease can spread unchecked in the interim.

Cattle infected with the culprit bacterium, *Mycobacterium paratuberculosis,* suffer chronic diarrhea. This results in lower weight, decreased milk production, and general poor health.

Costs to the dairy industry are substantial. Pennsylvania, one of the states hardest hit by the disease, reports losses of $20 million annually, according to a study by Robert H. Whitlock, of the University of Pennsylvania's School of Veterinary Medicine.

Until now, *M. paratuberculosis* has been difficult to distinguish from similar organisms in the diagnostic procedures used by laboratories, says Diana L. Whipple, microbiologist with USDA's Agricultural Research Service at Ames, Iowa.

But research aimed at developing a diagnostic test has recently enabled scientists to remove the genetic material, DNA, from this bacterium.

"We are excited about getting the DNA from our samples," Whipple says, "because it could make identification more accurate. It may open a new avenue to develop improved diagnostic tests and vaccines."

Whipple says the next step is to develop a gene probe—a small fragment of the bacterium's DNA that recognizes identical DNA by binding to it. After the probe is developed, researchers will label it with radioisotopes. Once it is radioactive, the probe will show up as a dark spot on X-ray film at the point where matching occurs. The telltale mark on the film will prove that the sample contains the bacterial strain that causes Johne's disease.

Young calves are most susceptible to infection. They swallow the organism while nursing from a contaminated udder. Their own mothers may be shedding the organism, or bacteria may accumulate in the calving area because of poor sanitation.

Cattle showing symptoms do not recover on their own, and there is no effective treatment for the disease. The main control method is to quickly identify the disease and cull out infected animals. Some infected animals don't show disease symptoms, but they can still carry the bacteria to other animals in the herd.—By **Linda Cooke**, ARS.

Diana Whipple is at the USDA-ARS National Animal Disease Laboratory, P.O. Box 70, Ames, IA 50010. ♦

Please Pass the Asparagus Fern

It's not quite planting the south forty on a balcony. But a USDA-ARS scientist has come up with a new asparagus that can do double duty in a hanging basket and on the dinner table.

Gilbert D. McCollum, a plant geneticist, wasn't looking for a new decorative plant back in 1980, when he began crossbreeding garden asparagus with related species, including its well-known fern cousin, sprengeri.

He was looking for a way to combat crown rot disease, a crop blight that costs commercial asparagus growers about $100 million every year, according to Rutgers University extension specialist Stephen Garrison. McCollum hoped to find a way that asparagus could acquire sprengeri's resistance.

When sprengeri proved unwilling to crossbreed with its garden variety cousin, McCollum tried mating the vegetable strain with wild asparagus.

No, he has not as yet succeeded in introducing crown rot resistance. But the experiments produced an unplanned happy variation—a new asparagus, decorative and droopy enough to fill a hanging basket while still producing edible stalks.

TIM McCABE

ARS plant geneticist Gilbert McCollum displays his new edible ornamental asparagus variety. (0887X808-17)

"We're not talking about enough stalks to feed a family, but you could certainly get a few for your salad," says McCollum.

The new asparagus has an advantage over the ornamental sprengeri which it resembles. It does not shed a shower of needles with every change of light or missed watering, a problem sprengeri owners know well.

The new asparagus is a hearty plant that will grow continuously indoors, although it may tend to become pot bound. "And it will survive the winter outdoors, although the foliage will die down and then come back in the spring," he added.

At least one company, Harris Moran Seed Co., has already expressed interest in the ornamental possibilities of the new asparagus.—By **Kim Kaplan**, ARS.

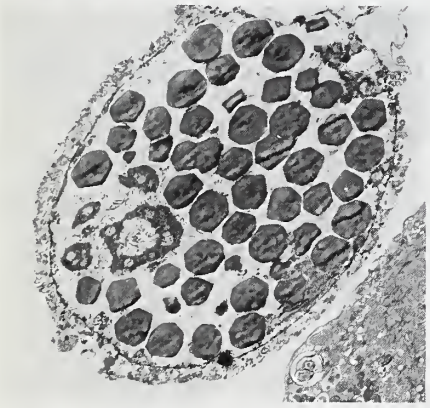
Gilbert D. McCollum is in the USDA-ARS Vegetable Laboratory, Bldg. 011, Room GH13, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ♦

War Against AIDS: The Armyworm Enlists

If the AIDS vaccine being tested by MicroGeneSys, Inc., is a success, a part of the credit will belong to the fall armyworm, an insect that preys primarily on corn and wheat.

MicroGeneSys is producing a basic component of the vaccine, which the Food and Drug Administration has recently approved for clinical trials. It

BARRY FITZGERALD



J.R. ADAMS

Top: Fall armyworm, notorious pest of corn and wheat, has joined the battle against AIDS. (0285X0066)

Above: Electron micrograph of a host fall armyworm cell infected with the virus (pebblelike shapes within the cell) used in experimental AIDS studies. Magnified about 3,200 times. (PN-7255)

is the latest refinement of a line of cells developed from the fall armyworm.

The cell line was originally developed by U.S. Department of Agriculture scientist James L. Vaughn at the Insect Pathology Laboratory in Beltsville, Maryland, in 1969.

"We developed it because we needed a system to let us study viruses that could be used to specifically attack insects that feed on crops," says microbiologist Vaughn. "The cell line is useful for basic studies and potentially for commercial replication of viruses."

MicroGeneSys researchers selected armyworm cells as the factories for the special protein primarily because the insect cells have membranes similar to those of mammalian cells but cannot pick up mammalian viruses that might contaminate the protein.

According to Gale Smith, director of molecular biology for the West Haven, Connecticut, company, "Without the background work of researchers like Vaughn, we could not have gotten to this point. A lot of the early work done in agricultural research is now really paying off."

MicroGeneSys actually refined Vaughn's cell line, which contained many different cell types, by selecting four specific types and then growing a pure culture of the less varied mixture.

Then the cells were infected with a virus containing a gene for the protein that makes up the envelope capsule of the AIDS virus. The insect cells make the protein, which is processed into the vaccine proper, he says.

No actual AIDS virus is used in the process, Smith stressed.—By **Kim Kaplan,** ARS.

James L. Vaughn is in the USDA-ARS Insect Pathology Laboratory, Bldg. 011A, Room 214, Beltsville Agricultural Research Center-West, Beltsville, MD 20705. ♦

A Breakthrough for Bottle Babies

Bottle-fed babies may have fewer digestive problems—and their parents more peace and quiet—if a natural protein in breast milk is added to infant formula, according to researchers at the U.S. Department of Agriculture's Children's Nutrition Research Center in Houston, Texas.

Lactoferrin, which literally means "milk iron," is known to help infants absorb iron from mother's milk and to protect them against intestinal infection. From new studies of laboratory rat cells, however, it appears that the protein also speeds growth and maturing of the gastrointestinal tract.

Two international formula makers have expressed interest in these findings.

Center director Buford L. Nichols heads the research, funded by USDA's Agricultural Research Service. He reports, "Infants who don't get mother's milk tend to have more colic, diarrhea, and food intolerances. Presumably, some of these problems are due to an immature digestive capacity."

"Our studies suggest that adding lactoferrin to infant formula will make it more like human milk."

He says that animals' intestines grow considerably during the first 1 to 3 days after birth. Newborn pigs, for instance, add 8 to 10 inches of intestine in that period. And studies of newborn pigs and other animals indicate that their digestive systems mature faster if they are suckled.

"This growth may not occur in infants who get formula rather than breast milk," Nichols says, "leaving them prone to chronic diarrhea and other intestinal problems."

To identify the growth stimulant, Nichols and technician Kathryn S. McKee devised an assay using rat crypt cells—the cells that generate intestinal lining. They looked for the component in human colostrum—the antibody-packed breast secretion preceding milk—that stimulated rapid division of these cells. It proved to be lactoferrin, which is most concentrated in the colostrum. The findings were reported in the June issue of Pediatric Research.

Since then, the researchers have looked at how infant formulas based on cow's milk or soy affect rat crypt cells. Both types of formula inhibited cell division, Nichols says, but adding lactoferrin in amounts comparable to those in colostrum restored cell division to normal rates.

He and McKee have applied for a patent for this use of lactoferrin through Baylor University's College of Medicine.—By **Judy McBride,** ARS.

Buford L. Nichols, M.D., and Kathryn S. McKee are with the USDA-ARS Children's Nutrition Research Center, Suite 601, 6608 Fannin St., Houston, TX 77030. ♦

ARS Sows New Crops in Oklahoma

RESEARCH MAKES JOBS

As part of an informal survey, our staff interviewed a number of agency scientists, farmers, ranchers, and small business owners across the country to find out how agency research is helping the people who run the farms and businesses that form the backbone of rural America. These articles reflect only part of the successes achieved by some 2,700 ARS scientists at 127 locations in the United States and overseas.—Ed.

Southeast Oklahoma—a place where people traditionally raise beef and hay or pump oil. Southeast Oklahoma—a place in economic depression because beef, hay, and oil currently mean low profits.

But peaches, watermelons, cucumbers, strawberries, cantaloupes, tomatoes, broccoli, Christmas trees, and even catfish could change rural Oklahoma's dreary economic picture, giving ranchers and farmers an alternative to the tradition of cattle and forage.

USDA's Agricultural Research Service, as part of an effort to introduce new crops like these to the region and diversify its agricultural economy, has joined in a unique partnership with Oklahoma State University (OSU) and with RedArk Development Authority, a state-created public trust intended to develop markets for the new crops.

Finding fruit and vegetable varieties that can handle Oklahoma's growing season, which has been described in many years as "too wet too late and too dry too early," is one of ARS' main goals, according to E. Van Wann, ARS research leader at the South Central Research Laboratory in Lane, Oklahoma, about 150 miles south of Tulsa.

But the lab's plans to help establish new crops depends on more than just finding the right varieties. "We must demonstrate to people that problems with new crops are solvable," Wann says. Many farmers are still sitting on the fence waiting to see how harvests turn out for pioneers in the new crops.

"Our presence here acts as encouragement," Wann says. "We can show them, for example, that with a tomato variety like Sunny or Mountain Pride, which the lab is growing experimentally, you can harvest $6,400 worth of fruit per acre. The cost of production runs $4,000-$4,400, depending on overhead. So an acre or two of tomatoes can be a nice supplement to a farmer's income."

Part of the objective is to convince people with no tradition of farming for the market that there is potential for producing fruits and vegetables for wholesale. Most people in the area, even those growing produce for roadside

ARS scientist Van Wann (third on right) works with Three Rivers Produce Plant manager Jerry Sears (fourth) in deciding which crops are most growable and marketable in southeast Oklahoma. This packing plant, built in 1985, provides jobs in the community as well as a market for local crops. (0887X825-25)

BOB BJORK

stand sales, don't have the basic information about how to grow crops commercially.

"We try to introduce them to the best commercial varieties of crops and recommend ways to grow them here in southeast Oklahoma," Wann says. "For instance, we brought in supersweet varieties of corn last year, even sweeter than Silver Queen. Before, the only corn grown here was not particularly commercial."

On the other end of the production chain is Three Rivers Produce, a vegetable packing and marketing operation of RedArk Development Authority, which was created in 1984 by the Oklahoma state government to help farmers to grow the produce and then develop markets for new crops. The premise behind Three Rivers was that it would be easier to get farmers to try a new crop if they could start with a few acres and have some assurance of a buyer.

Since Three Rivers began operations in 1985, the harvest of alternative crops has gone from 88,000 pounds of one crop—okra—to this year's 2 million pounds of 6 or 7 different crops grown by 22 farmers, according to Three Rivers plant manager Jerry Sears.

"That kind of growth means many of the people around here on small places—2 or 3 acres—can make money," Sears says. "This is a very poor part of the country, and many of our young people have had to leave to find a job. The new industry is very welcome here."

For example, with Three Rivers' help, Bobby Pruitt, a local student, has been able to make enough each summer from an acre of okra, one of the crops for which Three Rivers has opened a market, to pay his way through college.

But Three Rivers' marketing work cannot do the job alone. Just because you can sell tomatoes doesn't mean that any tomato will grow well in southeast Oklahoma.

That's where ARS comes in.

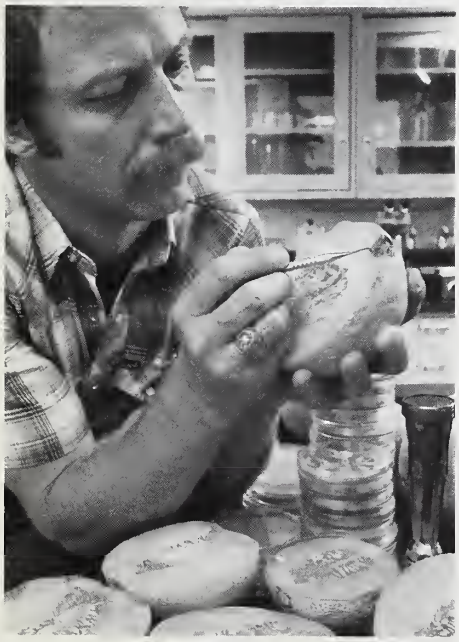
ARS scientists teamed up with researchers from Oklahoma State University in 1985 to open the South Central Agricultural Research Laboratory and Wes Watkins Agricultural Research and Extension Center. Named for Oklahoma congressman Wes Watkins, one of the Center's assignments is to determine which varieties of fruits and vegetables grow in this area and their fertilizer and moisture requirements. OSU provided the land, and ARS built the facilities. Researchers from both work together on projects and on helping farmers with new crops.

"What to grow is pretty much chosen for its market potential by Three Rivers, but it is up to the research center to figure out how to grow that crop," says Wann.

Without that kind of data, people testing alternative crops could end up with expensive mistakes and no harvest.

BOB BJORK

Left: Many wholesale produce buyers have expressed interest in Oklahoma-grown tomatoes. ARS' Van Wann is looking for a variety that does well under local growing conditions. (0887X815-29A)



BOB BJORK

Left, below: ARS plant pathologist Benny Bruton at the South Central Research Laboratory, Lane, Oklahoma, examines fungus that attacks ripening cantaloupes. (0887X822-12)

Below: Peaches may turn out to be a good crop for southeast Oklahoma but it takes 3 years for a new orchard to produce a cash return. At the Lane lab, ARS researchers experiment with vegetables that can be intercropped between young trees. (0887X818-32A)

BOB BJORK

For example, Three Rivers identified broccoli as a crop with a good potential market and signed up local farmers to grow a few acres. Unfortunately, much of it developed brown buds before the heads reached market size, according to plant manager Sears.

"Now we'll be growing test plots of broccoli to find a variety and growing methods that will work here and can be grown at a cost that will help the farmer turn a profit," Wann says.

Sears counts on this type of research data to avoid mistakes for other new crops that Three Rivers wants to sell.

Complicating the picture is southeast Oklahoma's diversity of soil types, according to Glen Taylor, director of OSU's part of the Lane operation. Such diversity means needing to find a variety of each crop for each soil type.

"Eventually, all of the data will be in a computer database. Then a person will be able to say I've got 32 acres of these types of soil and this much water, and the computer will generate a complete plan, with advice on how many acres of what crops in which soils," he says.

Just getting underway this summer is a major project cooperatively developed by ARS, RedArk, and the U.S. Fish and Wildlife Service—a projected 1-million-pounds-per-week catfish industry.

ARS fisheries biologist Wendell J. Lorio, is studying methods to help farmers raise catfish in ponds for RedArk's new fish-processing plant, which opened in August. "The techniques for catfish farming were worked out years ago for Mississippi, but we need to adapt them for Oklahoma," he says. The biggest problem is maintaining water quality while keeping a high enough number of fish per acre of pond to be profitable.

In addition to his experiments to raise more fish in less space, Lorio also gives advice to farmers in getting their operations started.

RedArk expects to pay about a $1 per pound to the fish farmers, according to Gary Ainsworth, RedArk's catfish project manager. Costs of raising fish are about 50 cents per pound, Lorio says.

Catfish are not only stimulating a new farm enterprise, but RedArk's processing plant is creating off-the-farm jobs.

BOB BJORK

"We have 10 people employed right now in the start-up phase and that will probably increase," says Ainsworth.

While Phillip Howard and his son-in-law Troy Henry aren't the first to try farming catfish in Oklahoma, they're the first to do so with ARS guidance. "A guy down the road tried it several years ago on his own and went broke," says Howard. "We depend on Dr. Lorio's advice to help us turn a profit."

Like many of those trying alternative crops, Howard is not quite ready to give up his cattle. "But raising beef here has become marginal. If the catfish work, we probably won't raise cattle at all."

By October, when the catfish reach 1 to 1-1/2 pounds harvesting size, Howard and Henry will know if they have a viable business and Oklahoma, a new industry.—By **Kim Kaplan,** ARS.

E. Van Wann and Wendell J. Lorio are in the USDA-ARS South Central Agricultural Research Laboratory, P.O. Box 159, Lane, OK 74555. ♦

BOB BJORK

Top: On Lake Texoma, RedArk's Gene Dodds (left) and ARS fisheries biologist Wendell Lorio are seeking ways to grow a profitable crop of catfish. (0887X828-12)

Above: Wendell Lorio (left), RedArk's Gary Ainsworth (center), and U.S. Fish and Wildlife Service technician Larry Norton examine a catfish that is nearing the 1 to 1-1/2 pound commercial-harvesting size. (0887X831-10)

Goodbye Boll Weevil. . . Hello Again Cotton!

RESEARCH MAKES JOBS

When Marshall Grant was a boy working on his family's cotton farm in North Carolina in the late 1930's, one of his jobs was to kill boll weevils. He did it by mixing molasses and calcium arsenate in a bucket with holes in the bottom. As he walked down each row, the mixture dripped on the cotton plants. Supposedly, the molasses attracted the weevils and the arsenic killed them. It was state of the art but not very effective, he recalls.

Over the years, as the weevil became established in the Cotton Belt, chemical insecticides replaced molasses and calcium arsenate. But as the costs for chemicals rose—and concerns for their effects on the environment increased—cotton acreage declined. Grant and other cotton farmers wondered if they could afford to keep on growing it.

Today they can, thanks largely to the Southeastern Boll Weevil Eradication Program, a cooperative effort between cotton growers, the U.S. Department of Agriculture, and state and local agriculture offices. The program began in 1978 in the northeastern corner of North Carolina, 86 years after the boll weevil crossed the Rio Grande into Texas and began its spread through the South.

The weevil, which feeds on the cotton boll, flourished in the absence of natural enemies and became established in the Cotton Belt by the 1920's.

But now Grant and other cotton farmers can walk through about 220,000 acres of cotton in the Carolinas and rarely, if ever, see a weevil. Since 1986, the weevil has essentially been wiped out in these two states.

"I think if my father were able to come back and see this, he wouldn't believe it," Grant says. "Before the eradication program started, we had a lot of farmers who just didn't believe this could be done. Now there's not a single farmer in all of North or South Carolina who questions its effectiveness."

USDA's Animal and Plant Health Inspection Service runs the program, based on research developed mainly byAgricultural Research Service scientists. USDA pays 30 percent of the cost; growers pay 70 percent. A majority of cotton growers in each state must vote for the program before it can begin. Then all growers must participate.

The program, which was completed in the Carolinas last year and is moving into Georgia, Alabama, and Florida this fall, works like this: Special traps containing weevil sex attractants, called pheromones, are put in cottonfields in late summer. The traps catch weevils and let scientists know how heavily an area is infested. Then malathion is sprayed on fields in the fall, killing weevils before they store up fat and hide under leaves and grass to survive the winter.

The next spring, traps are again set to detect any weevils that survived the winter. Malathion is sprayed in the spring to prevent survivors from reproducing and again in the fall of the second year if necessary.

These traps are a key element of the program. They remain in the fields to continuously monitor for weevils. An improved version of the trap was developed and patented in 1985 by ARS entomologist Willard Dickerson. The Southeast Boll Weevil Eradication Foundation, a group of cotton growers, has an exclusive license to manufacture it. The attractant was synthesized in 1969 by ARS chemist James Tumlinson.

Dickerson says the foundation has made about 400,000 traps so far and expects to produce another 1 million as the program expands over the next 2 years into 375,000 acres of cotton in north Florida, Georgia, and Alabama.

Ultimately, scientists hope to create a weevil-free cotton belt from the Carolinas to Texas. A similar program is also underway in Arizona and California.

Growers who are still fighting the weevil are hoping they benefit as much as those in the Carolinas have. Grant, for example, no longer has to use indiscriminate pesticides such as parathion, methylparathion, and guthion to control the pest. In the 1970's, before the program began, he sprayed these chemicals 10 times or more a season.

The same chemicals that killed the weevil also killed beneficial insects that fed on another cotton pest, the bollworm.

Now that the weevil is gone and the number of sprayings is down, the bollworm is easier to control. Grant usually applies pyrethroids twice a season to control it. The pyrethroids are

ROB FLYNN

North Carolina cotton farmer Marshall Grant has cause to smile. The Southeastern Boll Weevil Program has virtually eliminated this costly pest from the Carolinas. (0787X786-32)

more selective and less harmful to animals and beneficial insects such as ladybugs, spiders, wasps, and honeybees. Some of these are natural predators of the bollworm. Because of the boll weevil eradication, Dickerson says growers in the Carolinas have cut insecticide use by 60 to 70 percent.

Grant figures the program saves him $50 an acre in chemical spraying alone. An economic study this year estimates cotton farmers are making about $77 more per acre now that the weevil has been licked. That includes pesticide savings, increased yields, and switching to cotton from other crops worth less, according to North Carolina State University economist Gerald Carlson.

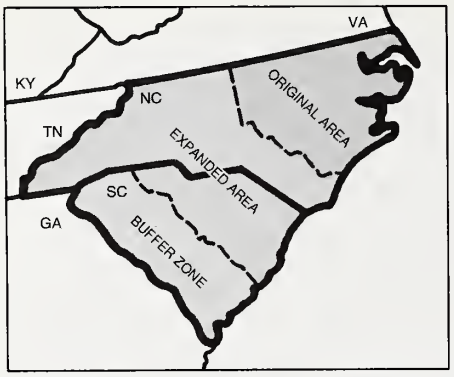
Rural areas of the Carolinas where cotton has been grown for decades are reaping the rewards of the program. Dickerson, based at Raleigh, North Carolina, estimates the program has brought eight new cotton gins and numerous gin improvements worth about $12 million to the state. The gins dry the cotton and separate it from the seeds.

The new gins are primarily the result of the eradication program. For example, a farmer cooperative in the Chowan County area has built two gins, at a cost of about $1 million, to handle the increased production. Clarence Leary, a cotton farmer and member of the cooperative, estimates that there are now about 100 growers in the area served by the cooperative, compared to 2 or 3 in 1978. Cotton acreage has jumped from about 600 to around 10,000 in the same period.

The co-op hires 30 workers during the October-to-January ginning season. It plans to pay off the construction loan this year after 6 years; originally, members thought it would take 20.

Aside from economics, the impact on the environment has been dramatic, Leary says. He sees quail, foxes, rabbits, "more of everything," returning to the fields since the program began. Beekeepers have brought their bees back into cottonfields, too, now that heavy insecticide sprayings have stopped.

The honey came in handy in more ways than one. Several years ago some growers in South Carolina were reluctant to support the referendum to expand the program in their state, mostly because of the up-front cost. (There was even more reluctance in Georgia because of last year's drought, but growers approved the program in a referendum last fall.)



The boll weevil was evicted from northeastern North Carolina by 1980, the expanded program area by 1985. A buffer zone prevents reentry.

So in his travels to meetings in South Carolina to convince cotton growers that the program really worked, Leary would give out sample jars of honey from his North Carolina cottonfields as proof of the reduced pesticide use.

The referendum passed in South Carolina in 1983. "Cotton's really picked up in this area since then," says Jimmy Lowder, a grower and gin operator in Oswego, South Carolina. "Some are back planting cotton after 10 or 15 years."

Another South Carolina grower, Robert Lee Scarborough of Eastover, has been growing cotton for a long time, since 1941. "The boll weevil became a problem in the 1920's, and we've been fighting it for survival ever since," Scarborough says.

But the eradication program has changed that.

"We're all real excited about it," Scarborough says. "Now we know that cotton has a future."—By **Sean Adams**, ARS.

Willard A. Dickerson, Jr., is in USDA-ARS Boll Weevil Eradication Research, 4116 Reedy Creek Rd., Raleigh, NC 27607. ♦

PASTURE Software Helps Small Farmer

Computers are not for big operators alone. One new computer program developed by ARS and the University of Kentucky helps small beef operators get the most out their grazing acreage.

PASTURE lets farmers ask "what if" questions—"What if I graze fewer or more cattle on this size field? What if I fertilize this month instead of next? What if rainfall is below normal? What happens if I use rotational grazing? " explains program coauthor Michael A. Brown, at ARS' South Central Family Farm Research Center in Booneville, Arkansas.

"PASTURE lets farmers project various management scenarios and see what happens to costs and returns," Brown says.

To operate the model, a farmer describes the type of forage and how it's managed. Then the program projects forage and animal production for the various combinations described.

University of Kentucky extension specialist Curtis Absher says the program helps farmers better utilize their forage. "It's an invaluable part of our Graze More Beef program, which aids the small farmer in Kentucky trying to use intensive grazing techniques."

Fertilizer, irrigation, forage types, weather, and costs can be factored into the program so the farmer doesn't need to try to calculate all the complex interrelationships.

"The farmer gets a clearer picture of how management choices affect costs and profits. This program can mean major savings, even on a small farm," Brown says. "I've played with a lot of sequences and seen tremendous differences in outcomes. For example, a farmer could decide to change forage types entirely based on what the program projects in terms of costs and returns."

The program was originally designed for a mainframe computer, but has been reformatted for use on more readily available personal computers. Software for PASTURE is available to extension agents from Brown.—By **Kim Kaplan**, ARS.

Michael A. Brown is at the USDA-ARS South Central Family Farm Research Center, Rte. 2, Box 144-A, Booneville, AR 72927-9214. ♦

New Uses for Starch From Surplus Corn

RESEARCH MAKES JOBS

Research on new products from surplus commodities continues to pay off for agriculture. One such project by USDA's Agricultural Research Service (ARS) turned surplus corn into super slurper—a substance that can absorb 1,400 times its own weight in moisture—and at the same time into new jobs in rural communities.

ARS scientist William Doane led a team of researchers in developing super slurper from cornstarch in 1974 at the Northern Regional Research Center in Peoria, Illinois. Since its development, super slurper has been used in body powder, diapers, and sanitary napkins; as a nonmetallic electrical conductor in batteries; and in other products as well.

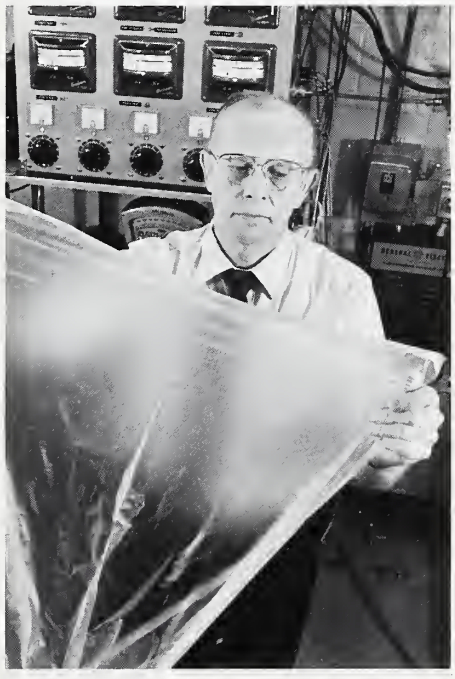
One rapidly expanding use for super slurper is in industrial fuel filters.

About 4 years ago, the Central Illinois Manufacturing Company in Bement, a small agricultural community in the center of the state, first developed these filters using a super slurper material it calls hydrosorb. The super slurper takes water out of the fuel as it passes through the filter.

". . .we are considering a multimillion dollar expansion soon so we can add new product lines based on super slurper."

Today, the company's hydrosorb filters are big sellers, according to Jim Womer, marketing director for CIMCo's petroleum division. The company makes 26,000 fuel filters a month using super slurper.

CIMCo has grown from about 25 employees 4 years ago to more than 100 today. The company's sales have grown to the point where other companies are buying hydrosorb to use in their filters. Womer says the demand was so great that his company licensed another one to make hydrosorb for the filters.



Top: This super slurper flake has swollen into a soft, rubbery chunk that is over 99 percent water. Made in flakes, films, powder, or mats from cornstarch, super slurper can absorb 1,400 times its weight in water. (0975R1878-20A)

Above: Chemist Felix Otey displays a large sheet of biodegradable plastic, made from starch and petroleum-based polymers. (098X1019-6)

Super slurper has also led to the creation of about 50 new jobs and the revitalization of a closed-down 30,000-square-foot bowling alley and recreation center into a thriving factory in Smelterville, a small town in Idaho.

The bowling alley/recreation complex originally shut down when the closing of the town's largest employer, Bunker Hill Mining and Smelting, Inc., in 1981 left the town with high unemployment.

But 18 months ago, the Marshall family, which owned the recreation complex, started Polysorb, Inc., to manufacture a whole line of products all based on super slurper.

Business has been booming for sales of Polysorb's medical cold packs, products to remove moisture from fuel tanks, and bulk absorbants for agricultural uses.

"We were in the black at the end of our first year, with about $3 million in revenue," says Cliff Marshall, president of Polysorb. "And we are considering a multimillion dollar expansion soon so we can add new product lines based on super slurper."

Another use for cornstarch is in plastics developed and patented by ARS chemist Felix Otey (now retired). These plastics have potential uses in trashcan liners, garden and farm mulches, and packaging for fast foods, says Don Fisk, president of Agri-Tech Industries, Inc., of Gibson City, Illinois. Agri-Tech was licensed in May to develop the cornstarch plastic for commercial use. Fisk says the company hopes to have a product ready for commercial manufacture in 1988.

Aside from its utilization of cornstarch, Otey's plastics have an environmental benefit: They are biodegradable. Doane says that preliminary laboratory studies showed the plastics would break down—if used as mulch in the soil, for example. Agri-Tech plans large-scale studies with different blends of the plastic to confirm this.

The potential for the starch-based plastic is good news for corn farmers, some of whom are helping fund research through the Illinois Corn Marketing Board.—By **Kim Kaplan** and **Sean Adams,** ARS.

William M. Doane is in USDA-ARS Plant Polymer Research, Northern Regional Research Center, 1815 North University, Peoria, IL 61604. ♦

Pick-Your-Own Profits

RESEARCH MAKES JOBS

Americans today have more leisure. They like outdoor projects that involve the whole family. And increasingly, they're willing to pay a premium for fruit that tastes as good as it looks. All these factors contribute to the success of a thriving pick-your-own farm on Virginia's Rappahannock River.

But research also plays a role in that success, say Charles and Anne Geyer, a husband-and-wife team of farm consultants who manage the Westmoreland Berry Farm and Orchard, near the village of Oak Grove.

The Geyers report that improved varieties of blackberries and strawberries developed by Agricultural Research Service plant geneticist Gene Galletta keep customers coming back for more, whether they pick the fruit themselves or buy it in the District of Columbia's fancy Georgetown markets.

The Geyers got acquainted with Galletta and his berry varieties several years ago when Anne and Charles worked for the University of Maryland on a cooperative project with ARS in Beltsville, Maryland, where Galletta is stationed. Now, a few years later, their 4 acres of blackberries include two of Galletta's thornless varieties—Chester and Hull. Fifteen acres of strawberries include three more ARS-Beltsville varieties—Earliglow, Lester, and Allstar. Lester and Allstar were introduced by Galletta and cooperators.

Plants are purchased from nurseries that reproduce them by tissue culture. That means they are uniform, true to type, and disease free.

"Gene's strawberries are full of flavor, and his blackberries are fat, sweet, and luscious," says Anne Geyer, who reports that last season, 2 acres of blackberries planted only 2 years earlier grossed more than $30,000. "And his blackberries are our highest profit item," she says, adding that the typical pick-your-own family that visits the blackberry rows buys from $18 to $20 worth of fruit.

"Some people drive 100 miles to get here," says Anne, pointing out that the farm is 2 hours' drive or less from three metropolitan areas—Washington, Richmond, and Baltimore.

Some 45 percent of the blackberries sold are picked by customers; the rest are trucked to retail markets by the Geyers, who have little difficulty in getting good prices for their produce.

"One reason is that if it isn't top quality fruit, it doesn't leave the farm," Anne says.

Other produce available for pick-your-own include asparagus; blueberries; tayberries (a blackberry-raspberry hybrid); black, purple, and red raspberries; and pumpkins. Other fruits raised and sold on the farm are picked only by employees and include peaches, apricots, sour cherries, plums, table and wine grapes, and apples. Preserves and jellies are made in the Geyers' kitchen and sold under the Westmoreland label at the farm's fruit stand.

According to Charles, investment per acre for the blackberries included $2,000 for wire trellises and $1,200 for a trickle-irrigation system. Water is pumped from the Rappahannock 100 yards away, and the system permits distribution of fertilizer with the irrigation water. Charles examines each foot of the system every 2 weeks to spot trouble.

". . . if it isn't top quality fruit, it doesn't leave the farm."

Galletta is available by telephone with advice on handling pests and plant diseases, although Charles' degree in agronomy and Anne's in biology enable them to solve most of their own problems.

Owner of the 1,600-acre corn-and-small-grain farm is Alan Voorhees, who contracted with the Geyers in 1983 to develop a supplemental crop of red raspberries. The consultants convinced him that he might obtain a higher profit by growing more diversified fruit and vegetable crops on 60 acres, including the pick-your-own feature for berries. Voorhees has had no reason to regret following their advice, since both production and sales have so far been impressive.—By **Hubert Kelley,** ARS.

TIM McCABE

Chester blackberries, fat and thornless, offer tasty pickin's to customers at Westmoreland Berry Farm and Orchard, near Oak Grove, Virginia. (0887X805-36)

Gene J. Galletta is in the USDA-ARS Fruit Laboratory, Bldg. 004, Room 111, Beltsville Agricultural Research Center, Beltsville, MD 20705. ♦

Heel Fly Project Adds Dollars for Ranchers

RESEARCH MAKES JOBS

Heel flies, tiny marauders which spend most of their life as cattle grubs, are a source of endless misery for cattle. Found throughout the Northern Hemisphere, heel flies put cattle on the run, damage hides and meat, and interfere with reproduction.

But a joint effort by USDA and Agriculture Canada has virtually eradicated the pest in a 300-square-mile test area on the Blackfeet Indian Reservation in Montana and in an adjacent area in Alberta.

And it's been good riddance. Not only are the cattle more contented, it's also meant extra money for ranchers, who estimate calves gain 10 to 25 pounds more in the area free of heel flies. With current prices, that can mean $7 to $20 a head more at selling time.

Cattle seem to fear the the heel fly even though it doesn't bite. The worst it can do is stick 300 to 600 eggs to the hair on a cow's belly or legs. Yet rancher Ray Martin reports seeing cattle "run into a lake and sink themselves up to their heads to get away from heel flies."

Once the eggs hatch, young grubs bore their way into an animal and begin a 6- to 8-month journey that takes them from the legs or underbelly to its back, where they cut a breathing hole and remain for up to 3 months more before emerging.

In trying to create a fly-free zone on the Blackfeet Reservation, scientists decided on a combination of two eradication methods to depopulate the cattle grub/heel fly. Every fall for 5 years, the 25,000 or so cattle in the zone were treated with an insecticide under the supervision of entomologist Philip J. Scholl of the U.S. Livestock Insects Laboratory in Kerrville, Texas. This lowered the grub population. Then the few insects that survived long enough to mature into flies were dealt a reproductive knockout punch the following spring: They were provided with mates that had been sterilized.

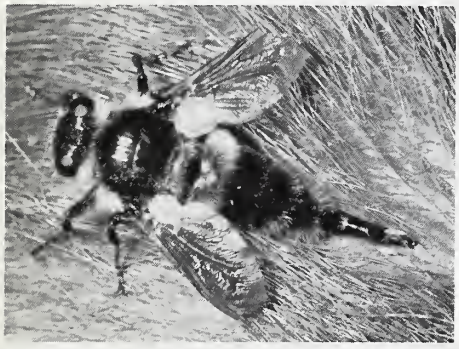
The campaign's results have been impressive. "My cattle have become docile now that the flies are gone," says rancher Lee Clark.

"It's easier to round up the animals and move them to other pastures now," reports another rancher, Bill Icenoggle. "We can do it anytime. Before, we couldn't do it in the heat of day because that's when the flies were at their worst."

This 5-year experiment has shown how future eradication campaigns could be conducted.

According to Sidney E. Kunz, director of the Livestock Insects lab, "Cattle grubs are found everywhere in this country. If the United States and Canada were to cooperate on a large-scale project, they could eliminate the cattle grub from North America with a combination of insecticides and sterile flies."—by **Don Comis**, ARS.

Philip J. Scholl and Sidney E. Kunz are at the USDA-ARS U.S. Livestock Insects Laboratory, P.O. Box 232, Kerrville, TX 78029-0232. ♦



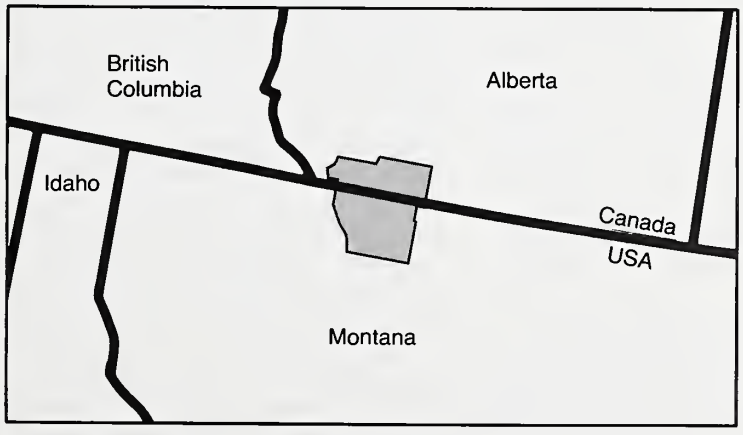
JERRY WEINTRAUB/AGRICULTURE CANADA

Left: A half-inch-long female heel fly, *Hypoderma lineatum*, lays her eggs on cattle hairs where they will soon hatch into cattle grubs. (PN 7254)

DOUGLAS COLWELL/AGRICULTURE CANADA

Left, bottom: Head of a newly hatched cattle grub, magnified about 4,000 times (PN 7253)

Below: In the shaded area spanning two nations, the heel fly has been completely eradicated.



Expanding Alaska's Farmland

RESEARCH MAKES JOBS

Delta Junction, Alaska, lies on the coldest, northernmost fringes of North American agriculture. To farmers and agricultural scientists alike, it represents a challenge not found elsewhere in the United States.

"To me, Delta Junction is one vast outdoor laboratory . Here we can see how Alaska's long, windy summer days, cold soils, and incredibly short growing season affect crops like barley," says research agronomist Jeffery S. Conn. He's with the Agricultural Research Service in Fairbanks—about 100 miles northwest of Delta Junction.

"We are just beginning to research ways of warming Alaska's frigid soils. . . so seeds will sprout earlier and plants will grow faster."

In 1978 and 1981, the State of Alaska held lotteries to sell the agricultural rights to 85,000 acres of farmland in the Delta Junction area. Since then, much of this land has been cleared of trees and brush.

There are now about 100 or so farms around Delta Junction, varying greatly in size from about 5 to 3,700 acres. Most are part-time operations worked by a single family.

Because spring-planted barley can grow to maturity in cool areas, it is considered better adapted to Alaska than most other grains and brings farmers the most money. Other crops grown include oats, wheat, and bromegrass.

Alaska-grown crops are used mainly to feed livestock within the state. Each year, about 2,000 acres of spring barley go into making a high-quality dogfood, which is bought by "mushers" for their dogsled teams.

One Delta Junction farmer-rancher, Barney Hollembeck, grows about a million pounds of Nugget bluegrass seed a year on about 900 acres of his 2,700-acre spread. Nugget is a winter-hardy, drought-tolerant lawn grass that stays green year round—except for 2 weeks in the spring—even beneath the snow in Delta Junction, where winter temperatures can drop to 60 or 70 degrees below 0°F. "Our biggest buyers of Nugget seed are the Japanese, French, and Malaysians," he says. "We've got enough orders to sell 60 times what we grow."

Hollembeck also grows barley, which helps feed his 400 beef cattle, as well as other varieties of bluegrass and creeping red fescue for seed.

Conn and co-workers, soil scientist Verlan L. Cochran and soil physicist Brenton Sharratt, are with the Subarctic Agricultural Research unit in Fairbanks. These ARS scientists are cooperating with researchers from the Agricultural and Forestry Experiment Station of the University of Alaska-Fairbanks—such as station director James Drew and resource management specialist Carol Lewis—to reduce wind and water erosion, using minimum tillage, and to improve arctic crop production.

"We are at the point in our agriculture where most other states were 50 years ago," says Cochran. "Alaskan farmers are doing without the specific information they need because the basic research is still being done."

According to Cochran, scientists cannot simply transfer information from similar studies in the "Lower 48." "For example, we need to know how Alaska's severe winters, short growing season, and days with up to 21 hours of sunlight affect the way nutrients like nitrogen and phosphorus move from the soil to the plant and then back to the soil."

Cochran is conducting the first Alaskan studies on nutrient cycling—the process by which substances like nitrogen and phosphorus are converted in the soil to usable forms of plant food energy.

Nitrogen conversion in the Lower 48 usually peaks around July, says Cochran. This gives plants a chance to stop growing and begin to mature. However, in Alaska, perhaps because of its short (3-1/2 month) growing season, the conversion continues, and crops like barley may not properly mature.

Since the 1978 and 1981 land lotteries, about 100 farms have been established near Delta Junction, Alaska.

"We are just beginning to research ways of warming Alaska's frigid soils," says Sharratt, who has been with ARS for less than a year. "Crop residues, tillage systems, and various planting schemes all have the ability to help seedbeds warm up faster in the spring so seeds will sprout earlier and plants will grow faster."

Besides controlling wind erosion and trapping valuable moisture, residues act as a mulch to regulate soil temperatures, he says. In the winter, these residues keep fields from freezing, but in the spring and early summer, they block the sun's rays and the soils stay too cool.

"We'll try different patterns of placing residues, covering some soil strips and exposing others, to get more balanced soil temperatures," says Sharratt.

It's also presumed that barley varieties with dark straw tend to soak up the sun's warmth and transmit it to the soil. "If this is so, we need to develop more of these dark varieties," he says. Sharratt also plans to color crop residues to see how this affects soil temperatures.

In addition, Sharratt, and University of Alaska-Fairbanks engineer Robert Cullum and ARS engineer Keith E. Saxton, who is in Land Management and Water Conservation research at Pullman, Washington, will test a new computer model Saxton designed to predict the effects of various tillage systems on the depth and duration of frozen soils.

"Climate extremes make Alaska an ideal place to test different ways of clearing and cultivating land," says Robert I. Papendick, leader of ARS Subarctic Agriculture Research, headquartered in Pullman. "Alaska's soils

are some of the coldest and most highly erodible in the United States."

Topsoil at Delta Junction—in places, less than 6 inches thick—covers gravel beds hundreds of feet deep laid down during a former Ice Age.

These soils must be farmed with great care to retain moisture and avoid erosion by high winds and water runoff. "In the spring, when it's dry, you get lots of dust in Delta Junction. It really blows out there, even the air gets brown. As you drive around the fields, you can see the dust running down your windows."

According to Conn, if farmers adopt practices that leave straw or other crop residues on the surface to protect soil from wind and hold moisture, it could help avoid this loss.

Although newly cleared land is generally free of weeds and soilborne diseases that affect such crops as barley, they may become a problem after several years of cropping. Leftover straws can create an environment that favors the growth of disease in barley by providing a host site for plant pathogens and for the insects that transmit them. In addition, the straw intercepts herbicides, thereby decreasing their effect on weeds.

After harvest, farmers will probably need to leave enough residues on the soil surface to combat soil erosion in the spring and disk once in the spring to control perennial weeds. "More than anything," says Conn, "farmers need to bring in more crops—particularly nitrogen-fixing crops like fava beans—and rotate them with barley."

Conn is currently studying the effect of wild oats on barley in Delta Junction. Although not yet a serious problem, "this weed could turn into a costly epidemic, overrunning entire fields."

One of his studies focuses on finding which of the herbicides registered for use by the Environmental Protection Agency best controls wild oats. Of the individual herbicides tested, he found that diclofop provided the best control when applied at high rates early in the season.

Alaskan farmers have been fighting bitter cold and frozen soil for many years. Now soil erosion and weeds are added to their list of problems. But with help from ARS , this newest threat to farming the Land of the Midnight Sun will be overcome.—By **Howard Sherman,** ARS.

Verlan L. Cochran, Jeffery S. Conn, and Brenton Sharratt are in USDA-ARS Subarctic Agricultural Research, Agricultural Experiment Station, University of Alaska, Fairbanks, AK 99775-0080. ♦

On the Horizon

The following developments from USDA's Agricultural Research Service are expected to move into commercial applications soon:

Designer plastic mulches. When preliminary results are confirmed, farmers may be ready to dress their crops in colored mulches—instead of traditional black—to improve plant productivity. Patrick G. Hunt of the USDA-ARS Water Conservation Research Laboratory in Florence, South Carolina, has found that tomatoes appear to grow better with red mulch, while potatoes prefer blue.

Easier-to-prune peach trees. Scientists at the Appalachian Fruit Research Center in Kearneysville, West Virginia, are trying to develop peach cultivars that are genetically semidwarf and that will require much less pruning than current varieties. They're also looking for growth regulators that will chemically prune peach and apple trees, reducing hand-pruning costs.

Better pickles with different flavors. Henry P. Fleming of the Food Science lab at Raleigh, North Carolina, has developed a closed pickle tank that is being used on a small-scale commercial basis by at least six pickle companies. [See *Agricultural Research,* August 1986, p. 15] Raleigh scientists are also working on genetically engineering fermentation bacteria that could be used in the closed tank to produce different pickle flavors.

Shiitake mushrooms. Researcher James P. San Antonio of the Vegetable Laboratory at Beltsville, Maryland, has studied these oriental mushrooms to help small farmers grow them on oak logs. Shiitakes are valued for their taste, shelflife, and vitamin D and protein contents. Production is rising; about $10 million worth of shittakes were produced in the United States last year, compared to virtually none in 1981.

A new paper pulp fiber. The woody plant kenaf, a relative of cotton, was studied by scientists at the Northern Regional Research Center in Peoria, Illinois, in the 1960's and 1970's as a source of paper fiber. Now a $300 million kenaf paper mill in Willacy County, Texas, is slated for ground breaking in late 1987 and for completion in 1990. A joint venture between Kenaf International and Canadian International Paper, the plant will initially process 40,000 pounds of kenaf grown by Rio Grande Valley farmers trying new crops.

New low-cost seed planter. Farmers who use conservation tillage to reduce soil erosion will benefit from a new seed drill developed by Keith E. Saxton at the agency's Land Management and Water Conservation laboratory in Pullman, Washington. The drill could cost about one-third as much as current drills, according to Greg Schmick, who owns a small company, United Ag Systems, near Colfax, Washington. Over the next few months, Schmick plans to build a field-scale prototype and to test it on his 300-acre farm.

Electronic weighing of cattle. Future ranchers will be able to weigh their herds more efficiently and accurately by using technology developed by agency researchers at the Fort Keogh Livestock and Range Research Station in Miles City, Montana. [See *Agricultural Research*, November/December 1986, p. 11] GeoResearch, Inc., of Billings, is marketing the technology to university animal researchers and within 2 years hopes to offer it to ranchers and farmers, says company president Douglas Richardson.—By **Sean Adams, Kim Kaplan,** and **Howard Sherman,** ARS.

CSR

PATENTS

Monitoring Microbial Pesticides

BTI, a crystal protein that has been isolated from the bacterium *Bacillus thuringiensis israelensis*, is a recent arrival on the commercial pesticide market. This bacterially produced substance is deadly to the larvae of certain biting insects such as mosquitoes, black flies, midges, and horn flies.

Although the substance effectively kills insects, scientists were unable to agree on how—or why—it works. To help answer these questions, an ARS scientist invented an assay method that uses a biological-chemical tracer to measure the chemical's presence.

Derived in part from mouse spleen cells, the tracer is designed to chemically highlight the insecticide's path as it is taken up by the organism.

This invention can help manufacturers of the insecticide attain better quality control, product standardization, and measurement. It is also expected to assist researchers in development of new BTI-based products.

For technical information, contact Kevin B. Temeyer, P.O. Box 232, USDA-ARS Livestock Insect Laboratory, Kerrville, TX 78029-0232. Patent Application Serial No. 07/050,451, "Monoclonal Antibodies to Crystal Protein of *Bacillus thuringiensis* subspecies *israelensis*." ♦

Upgrading Fats and Oils With Enzymes

There's a way to convert used or low-quality fats and oils into fatty acids and glycerol—important industrial ingredients for a host of products such as cosmetics, drugs, inks, lubricants, and tires.

It's a process called hydrolysis, and ARS scientists are patenting ways to improve it.

Current heat-processing hydrolysis methods require huge steel vessels and costly heating equipment, and they risk polluting the environment. The product may still smell so bad that secondary deodorizing is a must. And despite all this effort, the product's impurities may limit its use to soapmaking.

But new, cold methods put the enzyme lipase to work as a catalyst to produce a product that is odor free and considerably purer. [see *Agricultural Research*, September 1987, p. 16] With one such cold method, the fats slowly move through a lipase-impregnated membrane, ending up in a mixing chamber.

An ARS scientist has patented a way to hurry the process along by lowering the pressure in the mixing chamber. The fat or oil moves through the catalyst-laden membrane more quickly, and the catalyst stays in place, contrary to expectations that it would be dislodged by the flow.

The patented system is easier to control and operate. Reaction activity is higher, translating into faster processing.

For technical information, contact Frank Taylor, USDA-ARS Engineering Science Research, Eastern Regional Research Center, 600 East Mermaid Lane, Philadelphia, PA 19118. *Patent Application Serial No. 06/860,360, "Reactions Between Immiscible Fluids."* ♦

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